THE THEORY AND PRACTICE OF LAW DIFFERENTIALS

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Introduction.

The principle of law differentials in its application to the computation of compensation rates needs no defense at this time. It has proven itself almost indispensable in meeting the practical problems of compensation insurance at the time of the introduction of every new law, and is still of great help in those states where compensation laws have been in force for some years, and local experience has been accumulating.

When the method was devised, the situation in compensation insurance was very critical indeed, and it is difficult to speculate as to what the development would have been if some objective method, independent of crude underwriting judgment and competitive underbidding, had not been devised—a method which immediately achieved well nigh universal confidence, not because of any claim at infallibility but because of convincing proof of honesty in its application.

It is well to remember that the method was devised under pressure of immediate demands of the moment, and that the details of the application of the method suffered, even more than the principle itself, because of many limitations of doing a piece of scientific work under conditions of an acute business situation. Moreover, it was admitted at the time by those who were directly engaged in the elaboration of the principle, that in the form in which it was originally applied it was but a crude approximation which would require numerous refinements in the near future. As more than three years have passed since the first application of the law differential based upon the Standard Accident Table, and since comparatively few changes have been introduced in the method of its application, the time seems ripe for a careful examination of the entire method, to discover the true uses, its necessary limitations, the possible sources of error, and available methods for their elimination.

Historic Note.

It is a curious fact that with its thirty years of compensation experience, European insurance practice did not, as far as the present writer is aware of, develop the method of differentials. To be sure, the necessity for any such method was very much less felt, in fact may be said to be lacking altogether. The need of law differentials arose out of the multiplicity of laws, resulting from our peculiar political constitutions. Since European acts are national in their scope, there is no necessity for local law differentiations. Of course, at the time of the introduction of the compensation legislation, many a European country might have profited considerably and perhaps avoided a good many pitfalls, if it had the method of law differentials at its disposal and thus could make use of the loss experience of other countries for the computation of its own rates. Perhaps the failure to do so may be explained by the fact that the pay-as-you-go method of German compensation insurance, and the futility of the Austrian efforts to provide sufficient reserves, made the utilization of the experience of both those countries impossible for the other countries. Moreover, the differences in the industrial conditions of the different countries prevented any feeling of security in dependency upon the experience of foreign countries in the entire matter of compensation costs.

The method might have proven more useful for a different purpose, for which it has been used very largely in this country—namely, the adjustment of rates to changes in the benefit scale. Of course such changes have taken place in European legislation as well, though perhaps not as frequently as in this country. But for some reason, neither any standard accident table, nor, what is more important, the principle upon which the Standard Accident Table is based, has been promulgated until 1914. A proper adjustment of rates to a change in a benefit scale is a matter of minor importance where assessment insurance prevails, as in Germany, or other forms of mutual insurance. And stock insurance, which, more than any other form, needs a scientific basis for rate-making, is but slightly developed in this field of insurance in most European countries. When stock insurance does exist the conditions of rate control are absent altogether, competition in rates is permitted, and in the adjustment of rates to the varying requirements of the business, European stock insurance companies in this field

were evidently depending largely upon crude underwriting impressions.

The Underlying Principle.—What, briefly, is the actuarial principle involved in the system of law differentials? It is that—other things being equal—the cost of compensation, and therefore the level of compensation premiums, under different acts must be in proportion to the benefit scales provided, so that if the benefits under Act B were twice as liberal as those under Act A, the rates should also be twice as high. While the above observation is altogether obvious, opinions may differ as to the best method of ascertaining this difference between benefit scales of different laws. Recently this question assumed the form of controversy between the "experience method" and the "valuation method" which might be called respectively the retrospective and prospective method of computing the relationship between two or more acts. The respective merits of the two methods will be compared presently, but it is evident that the experience method at best is only available after a sufficient amount of time has elapsed since the act went into effect, and that for new acts, which was the problem in 1914, some prospective method became inevitable. What is the fundamental thought of this prospective method?

If all the accidents were of the same quality, or if the differences in the scale of benefit were perfectly uniform for all the kinds of accidents, the problems would have been comparatively simple. But in actual practice the situation is very much more complex, because there are so many different kinds of accidents and so many different standards of liberality in compensating these different kinds of accidents. The first effort to compare the cost of two acts which differed in a great many details, namely, the Massachusetts Act of 1911 and the New York Act of 1913, disclosed so many uncertainties that one was tempted to give up in despair, until the Standard Accident Table provided a convenient yardstick.

It is only fair to point out that before the Standard Accident Table was prepared, an effort was made to compute differentials for a limited number of states by Dr. E. H. Downey and Mr. S. Bruce Black, then both of the Wisconsin Industrial Commission. The claim was not made, however, at the time that the results may be utilized for purposes of rate-making. It was largely a comparison of "the various state compensation acts as they affect the workingman."

A common laborer, earning $2 a day, aged 30, with a wife aged 28 and four children aged 2, 6, 8, and 10, was taken as standard. By this method the effect of many differences in compensation scales was disregarded, the cost of medical aid was altogether omitted, and the accident experience for two years in the state of Wisconsin was the basis of computation. It is, perhaps, important to add that notwithstanding the many crudities of this method, the results were not so hopelessly different from those later obtained by the Actuarial Committee of the National Workmen's Compensation Service Bureau, the only serious difference being in the case of the Illinois differential. Dr. Downey has called my attention to the fact that the Wisconsin differential referred to the Illinois Act of 1911, and the Bureau differential to the Illinois Act of 1913, so that even in this case the discrepancy is only a seeming one.

States.	Wisconsin Differential.	Workmen's Compensation Bureau.	Converted to Wisconsin Basis.
Wisconsin	100	150	100
Illinois	79	137	91
Iowa	68	104	69
Michigan	69	104	69
Minnesota	75	115	77

The Wisconsin computation proceeded from the following reasoning. All the 13,463 accidents which were compensated for in Wisconsin, if compensated under the Minnesota scale, would have cost 75 per cent. of what they did cost in Wisconsin. Evidently this would not hold true if, for instance, only fatal accidents were taken because the relative cost of the 268 fatal accidents under the various scales was as follows:

		Fatality Differential.	General Differential.
Wisconsin	$364,495	100	100
Illinois	359,670	96	79
Iowa	282,951	78	68
Michigan	277,216	76	69
Minnesota	317,888	87	75

Would the same relationship also hold true if individual classifications were taken? This question was not raised in the Wisconsin report because, as already stated, its problem was not the problem of rate-making, but only the problem of comparative liberality of acts. An affirmative answer was given to this question by the

Differential Committee 1914. But in justice to the Committee it must be stated that this affirmative answer was not a matter of conviction, but only of expediency. In my first paper on the "Scientific Methods of Computing Compensation Rates" (*Proceedings,* Vol. I, p. 10), the theoretical inadequacy of such an affirmative answer was very frankly admitted and it was stated then that "theoretically different standard accident tables should be compiled for each classification or at least for each large industrial group. We may feel that we have accomplished a good deal in achieving justice as between one state and another, without claiming equal justice between classifications."

In other words, it was recognized that the varying differentials of different accident classes made some method of weighting these differentials imperative, and some assumed distribution of accidents according to gravity was necessary, in order to offer some basis for this weighting. For this purpose the Standard Accident Table was prepared.

It may be recognized that the Standard Accident Table at that time saved the situation for the entire compensation business. The table proved even more useful and enduring than its compiler had dared to hope at the time. Official sanction was given to it on December 3, 1915, when the Joint Conference by a unanimous vote adopted the recommendation of the Committee on Loading and Differentials that "a valuation upon the Standard Accident Table at present affords the best basis for the computation of law differentials," and the propriety of applying a uniform law differential was not even questioned. Another year of experience raised several questions, but nevertheless for various reasons, the Actuarial Committee of the Standing Committee on Compensation Rates, as late as February of the current year, resolved that "the system of single law differential adopted at the last Conference be reaffirmed."

This steadfast adherence to the method must prove a source of great satisfaction to everyone who has been more or less identified with the elaboration of the original method. Nevertheless, a frank recognition of the provisional character of that method as suggested in 1914, and the accumulation of a vast amount of experience since then, makes at this time a careful reconsideration of the entire differential method highly desirable if not imperative. And it is hoped that no prejudice or bias will be charged against this criticism emanating from one of the three members of the original Differential Committee.

Has the differential method proven universally applicable? The increasing number of exceptions in the rate sheets of the various states seems to point out that under certain conditions the differential method is either inapplicable or unnecessary.

"Dr. Rubinow will perhaps agree with the statement that in this country with the many different state systems of workmen's compensation and the diversity of constructions adopted in administering the laws, the law differential will soon have to give way to experience in the determination of rates," says Mr. Ryan (*Proceedings,* Vol. II, p. 264).

I am, unfortunately, unable to agree with this statement without some substantial qualifications. Experience alone, without modification by means of law differentials, means experience of one state only, and to be a sufficient guide for rate-making, must be sufficiently broad. How broad it must be, *i. e.,* specifically how large the payroll exposure must be, is a question that has been carefully considered by the ablest mathematicians of this Society,* but as yet no scientifically accurate answer has been given, beyond Mr. Mowbray's statement, that "it will become more and more important to have clearly in mind some standard of exposure to be considered dependable."†

It would seem clear, however, even to the non-mathematical mind, that the mathematical effort is directed towards ascertaining the minimum dependable exposure; that the increase of the exposure beyond that minimum cannot make it less dependable; and that, therefore, without mathematical accuracy a dependable exposure must sometimes be reached in specific classifications of certain states. It is also generally admitted that the necessary exposure varies inversely to the premium level, or which is the same thing, that we may speak of the dependable exposure in terms of premium rather than payroll. Until the mathematicians agree, an empirical formula may prove useful, especially since the fluctuations in the pure premium below a certain percentage are of little importance. A very crude empirical formula was suggested in my paper three years ago. "Only then may we begin to speak of a dependable experience when at least one accident will not seriously disturb the average pure premium."‡ Suppose we grant that a

* Mowbray, *Proceedings,* Vol. I, pp. 24–30; Fisher, *Proceedings,* Vol. II, p. 276.

† *Proceedings,* Vol. II, p. 278.

‡ *Proceedings,* Vol. I, p. 13.

disturbance of the pure premium by not over 5 per cent. is not very serious. And suppose under a certain law, the maximum death benefit is limited to $4,000. Any pure premium volume of $80,000 would seem to offer a dependable basis under the circumstances. With a pure premium of 25 cents, this would require a payroll exposure of $32,000,000. With a pure premium of say $2.00 only $4,000,000. Surely there are numerous classifications which would satisfy such a requirement in many states. The standard may be doubled and even increased tenfold, without making impossible for some states to produce, if not in one year, then in a few years, a dependable experience of its own. This is especially true of certain large industrial states of the east. In New York state alone, for instance, according to the Census of 1910, there were 80 manufacturing industries with an annual payroll exposure of over $1,000,000, 23 of them with a payroll exposure of over $5,000,000, 11 with an exposure of over $10,000,000; and 4 with an exposure of over $40,000,000 a year. By this time, due to the normal growth, the extraordinary industrial activity, and the substantial increase in money wages, the number of dependable exposure is very much larger. Surely the classification of "Clothing, Men's" or "Clothing, Women's" or "Machine Printing," in the state of New York does not need any law differential to determine its true pure premium—provided, of course, that the law, or at least its scale of compensation benefits has not been modified meanwhile. And I believe that in such cases the law differential method should be definitely abandoned, and entire reliance given to individual state experience. It would seem that a state authority entrusted with rate supervision would be justified in creating such a list, and gradually adding to it, so that in case of discrepancy between the local pure premium, and that derived from the basic pure premium, the latter should be definitely discarded.

So far is Mr. Ryan's statement correct. And in many other states other or, perhaps, similar branches of industrial activity are similarly situated. But even if this were true of the greater part of the entire payroll exposure, which I believe is doubtful, even then would the method of law differentials remain useful, nay, altogether necessary, if compensation rate-making is to remain free from guesswork or manipulation. Even taking the country as a whole, in 1914 there were 69 specified industries (which include many classifications) with a payroll less than $1,000,000 out of a

total number of 256 industries specified, and 156 of them had a payroll of less than $5,000,000.* And what would become of the smaller states with a scattered industrial activity? Let us take one or two such states of the United States. In Nebraska, 25 industries are listed for 1909, and only 3 of them had a payroll over $1,000,000, the highest being less than $4,000,000. In North Carolina, out of 44 industries listed, only 2, cotton goods and lumber, rise to $10,000,000 or over, while 38 had less than $1,000,000 payroll, and 24 less than $100,000 a year.† Often a classification with a substantial exposure in one state may have a very small one in another state. The desirability for the latter to draw upon the experience of the former is obvious. Still more frequently the industry is so thoroughly scattered that no one state can expect to accumulate the necessary experience and a combination of the experience on a national scale becomes necessary. A law differential is the necessary instrument for affecting such a combination. I am aware of the fact that an entirely different remedy was ably suggested for this difficulty by Dr. E. H. Downey in his paper on "Classification of Industries for Workmen's Compensation Insurance,"‡ namely, a reduction in the number of classifications, not only by the establishment of the groups, as is being done by the Joint Conference in the preparation of pure premiums, but also by an entirely different system of classification based upon fundamental processes of operation.

This raises the very complex problem of classifications which lies largely outside of the domain of the problem studied in this paper. I have no intention to complicate matters by any excursion into other fields. It is referred to briefly here, only for the reason that the law differential and a simplified classification may be brought into opposition as two alternative methods of dealing with the same problem of insufficient exposure. In fact, this argument is made to some extent by Dr. Downey when he says: "There are somewhat narrow limits of time and space within which exposure are comparable," and again— "Great caution must be used in combining pure premiums experience under different laws. As to the combined pure premium for a long term of years, under different compensation acts, and in widely separated localities, the factors of

* Statistical Abstract for 1916, Table 127.

† Census of 1910, Vol. IX, p. 915.

‡ *Proceedings,* Vol. II, p. 10.

disturbance are so numerous and so potent that the aggregate result must be thoroughly untrustworthy." Under certain conditions these strictures may be fully justified. But they do not offer a sufficient basis (nor does Dr. Downey offer them as such) for rejecting the method of state law differentials IN TOTO. Surely no one would suggest that the experience of any state or any classification be cut up on territorial lines, and experience of different states does not as a rule mean the experience of widely separated localities.

In fact some of the arguments advanced by Dr. Downey substantially strengthen the case in favor of law differentials. For it is undoubtedly true that often limits of time circumscribe the usefulness of experience gained. It follows, therefore, that in so far as experience may rapidly become antiquated, what is lost in this direction must be gained by the widening of the area of observation, which again means the dependence upon law differential. Of course, if the compensation insurance business were willing to establish a new simplified system of classifications with a much reduced number of hazard classes, then the independence of *some* states (and only some) from the experience of any other state might become possible. But so far as known, no such changes are even contemplated. And finally, the differential method preserves its usefulness at the time of introduction of any new law, and within the limits of any one state, every time changes are introduced in the benefit scale.

If the law differential is thus not only justified historically but proven to be a factor of permanent value in compensation rate-making, a criticism of its methodology becomes decidedly worth while, and after over six years' experience with compensation insurance, and three years' utilization of the differential method, the time seems sufficiently ripe for the occasion.

In actual practice both the combination of experiences of many states and the derivation of the rates for separate states from our basic rate has been done on the basis of the Standard Accident Table.

In the report of the Actuarial Subcommittee of the Joint Committee, the following suggestion has recently been made:

"The Committee recognized that the rise of experience differentials would simplify many parts of the work. . . . Such a differential of necessity combines in itself all of the factors by which

we would pass from the basic pure premium to the state pure premium for the latest experience available and the resulting problem would be merely to pass from such latest experience to the probable experience of the period for which the rates are to be made. A majority of the Committee, however, felt that the departure from past practice was too radical and the volume of data and the extent of time at the disposal of the Committee too limited to warrant the abandonment at this time of established methods."

Again, it is necessary to point out that the suggestion as to the use of experience differentials is not entirely new. In 1915 the effort has been made to check up several state differentials by comparing the actual experience. The results were, as far as the writer remembers, not uniformly satisfactory, though on the whole lending support to the prospective method.

The method of experience differentials deserves a good deal more attention and confidence than it has as yet received. If, for instance, the results of the experience were altogether contrary to those derived from the valuation method, public policy as well as good business sense would demand that the latter should be discarded. Employers should not be expected to pay more than the actual cost, and the insurers should not be required to carry the risk at a rate below cost just because an abstract formula produces certain figures. Theory must yield to facts, rather than facts to preconceived theory.

Several difficulties of the experience method must, however, be taken into careful consideration. Complete reliance on the relation between the average pure premium of two states would be grossly misleading, because the difference might be due entirely to unequal distribution of hazardous and non-hazardous industries in the two states. The total loss of one state may be computed on the basis of the exposure of the basic state, the payrolls of the various classifications in basic State A being multiplied by the respective pure premiums in State B, and the theoretic loss thus obtained being compared with the actual loss in State A. Here is a hypothetical and simplified illustration.

What conclusions may be derived from the above facts? The average pure premium in State A by actual experience is 99 cents and in State B is 48 cents. If State A be assumed as the basic state then the differential for State B on the basis of the combined experience appears to be .485. If the pure premiums of B are

applied to the payroll of State A the average pure premium obtained is 168, and the differential appears to be 1.697. If the pure premiums of State A are applied to the payroll B, the average pure premium appears to be $1.34 and the differential for B figures at (48:134) .358. And finally if the combined payrolls are treated by either series of pure premiums, the resulting differential is .935.

Class.	State A.			State B.			Losses if Payroll A. and P. P. as in B.	Losses if Payroll B. and P. P. as in A.	Losses on Combined Payrolls A. and B. if	
	Pay-roll in (1,000).	Losses.	P. P.	Pay-roll in (1,000).	Losses.	P. P.			P. P. as in A.	P. P. as in B.
1	5,000	62,500	1.25	200	5,000	2.50	125,000	2,500	65,000	130,000
2	2,000	10,000	.50	300	1,200	.40	8,000	1,500	11,500	9,200
3	1,000	7,500	.75	1,000	9,000	.90	9,000	7,500	15,000	18,000
4	300	300	.10	2,000	1,000	.05	150	2,000	2,300	1,150
5	200	4,000	2.00	5,000	25,000	.50	1,000	100,000	104,000	26,000
	8,500	84,300	.99	8,500	41,200	.48	143,150 P. P. 168	113,500 1.34	197,300 1.16	184,350 108½

Which of the four differentials is valuable for rate-making purposes, .485, 1.697, .358 or .935? It would not do to argue that the illustration damns the whole method of differentials as untrustworthy, because the differences for individual classifications are so wide. The amount of exposure in almost each case is so small that the pure premiums are unreliable if taken separately, and I believe every member of the Rate Conference will corroborate the statement that actual experience showed even wider fluctuations. To be sure, the entire illustration is purely hypothetical. In actual practice differences in weighting individual items for the purpose of obtaining a weighted average do not so forcibly affect the final result, as is possible to show by means of an arbitrarily chosen illustration. But the writer states on his honor that the figures were selected without bias, just as they happened to come along in order to test the theory.

What guidance for rate-making does one obtain from these figures? Simple inspection seems to indicate that State B has a cheaper law than State A. But how much cheaper is it? An accidental death in the 5th classification in State A and in the 1st classification in State B creates a situation that baffles even efforts to check a differential, let alone obtaining one from the figures at hand. Yet the essential difference in the distribution of the payroll is not greater than may be observed when one compares

mining states with lumbering states, large metal-working states, textile states, and so on and so forth.

It is not my intention to argue that the experience-differential method should be entirely discarded. Possibly the solution may be found in applying the pure premiums of every state to a standard payroll, prepared from data for the entire country, or for certain sections of the country. Even then the danger of undue influence resulting from an accidental heavy loss in a classification of very small exposure might remain. Perhaps this could be corrected by eliminating or consolidating the experience of classifications with a very small exposure. But enough has been said to indicate that the retrospective method is not as simple as it might look at first glance, that it has many pitfalls, unless, indeed, the exposure on individual classifications is large enough to offer a sufficiently broad basis for a fair average, and it has already been admitted that in such cases no differential at all is necessary as far as that particular state and classification is concerned. Whenever this condition is absent, the valuation method still retains its usefulness.

The Standard Accident Table.

At the basis of this valuation method lies the Standard Accident Table. Does it meet all the demands that must be made of it? Is it sufficiently accurate for the purposes to which it is applied? It will probably be admitted that I need not be suspected of any undue prejudice against the Standard Accident Table. As a preliminary study and still as an emergency measure during the strenuous days of 1914, I believe that the Standard Accident Table has amply justified itself.

The essential factor in its construction is the distribution into five groups.

Total	932
Total permanent disability	133
Permanent partial disability	2,442
Dismemberment	2,300
Total temporary disability	94,193
	100,000

There have been several criticisms of these major classifications by more or less prominent statisticians, of which perhaps the most careful was that by Professor Willard Fisher, in the *American Economic Review* for December, 1915. Though on the whole the

review is favorable, Dr. Fisher seems to have questioned the fundamental underlying principle of the Table when he writes:

"Dr. Rubinow's fundamental assumption that the distribution of injuries will be approximately the same in all lands . . . is not consistent with the intrinsic probabilities of the case." It is perhaps unnecessary to argue this point at this place, because that has already been done before,* and because without this fundamental assumption there is no purpose in the compilation of the Table.

The specific criticisms of Dr. Fisher were directed against the assumed number of total and permanent disability and of partial permanent disability cases, and their distribution by degree of disability. Most of the criticisms, oral or written, have been directed largely at these two points. Nevertheless, such evidence as has developed until now seems on the whole to corroborate the table at least in its essential outlines and recognition of this fact is not wanting.

That seems to hold true of New York experience (see Dawson, *Proceedings,* Vol. I, p. 104) except for permanent disability cases, which had not developed because of lack of time, of the Nevada experience, except for a higher proportion of fatal accidents because its experience largely refers to mining industry.†

Thus the New York comparison:

	No. of Cases (Rubinow).	No. of Cases (Actual).
Fatal	16	16
Dismemberment	42	44
Total permanent, not dismemberment	2	1
Partial permanent, not dismemberment	44	0
Temporary total, not compensatable	1,098	1,014
Temporary total, compensatable	598	725
	1,800	1,800

And the Nevada comparison:

	Standard Acc. Table.		Nevada Experience.	
	No.	P. C.	o.	P. C.
Fatal	932	.93	.75	2.34
Dismemberment	2,323	2.32	.65	2.02
Total permanent dismemberment	110	.11	.02	.06
Partial permanent dismemberment	2,442	2.44	.80	2.49
Total temporary	94,193	94.20	29.91	93.09
	10,000	100.00	32.13	100.00

* *American Economic Review,* March, 1916, pp. 250–258.

† Nevada Report of Industrial Commission, 1913–1916, p. 10.

But while the Standard Accident Table has justified its use at least in an emergency, it is by no means so perfect that no revision is required.

Not only should we be in a better position now than we have been three years ago to do that, because we have or should have that much more experience to draw upon, but also because we have had that much more time to study the problem and gather material.

The following criticism may be made at least tentatively against the Standard Accident Table:

It is based almost exclusively upon European data, which were the only ones available at the time. But since its use is primarily intended for comparisons between one state and another on this continent, it would be desirable and would meet a good deal of criticism, if at least gradually data from American experience were carefully gathered. It is at least possible that modern treatment and modern American surgery have substantially affected the table in certain points, as, for instance, in the elimination of some permanent disability cases.

It is true that notwithstanding five or six years of compensation, American accident statistics is still far from ideal, nevertheless, some valuable data are being sporadically published by some of the compensation states—notably California, Wisconsin, New York, Massachusetts, Michigan, Illinois, Maryland, Washington, Nevada and others. Massachusetts data for one year was utilized to some advantage in the construction of the Standard Accident Table. There is no scientific reason why other statistical data which have accumulated since then should not be utilized as well. This is not devoid of many difficulties. Notwithstanding a good deal of discussion the hope of a uniform system of compensation statistics is still one of those hopes deferred which maketh the heart sick. There is no dearth of organizations which seems to work for such uniformity:

1. The Statistical Committee of the National Association of Industrial Accident Boards and Commissions.
2. The Compensation Committee of the National Association of Insurance Commissioners.
3. The Statistical Committee of the National Workmen's Compensation Service Bureau.
4. The Casualty Actuarial and Statistical Society of America, and
5. The United States Bureau of Labor Statistics.

These are all organizations interested in the ideal of uniformity. But a recent effort to combine all available statistics of accidents convinced one that as yet very little has been accomplished. Over a year and a half ago, the Actuarial Committee of the Joint Conference on Workmen's Compensation Rates made the following recommendation to the Conference:

"The Committee feels . . . that the Conference should recommend to the Casualty Actuarial and Statistical Society of America that at its early convenience it take the necessary steps towards the development of a new table based upon an enlarged American experience."

As yet nothing has been accomplished beyond the adoption of this recommendation, at least nothing that the public at large is aware of. It is singular that the little isolated state of Nevada, with its small state fund, should remain almost the only state which published scientific compensation accident statistics in conformance with the uniform standard and readily comparable with the Standard Accident Table.

It is quite likely that because of the heavier character of American industry, a higher proportion of fatals should be assumed. The total number of dismemberments may be fairly accurate, but it at least is possible that its structure will require substantial modifications. The schedule of dismemberments was adopted from the statistics of only one country—Austria. Besides, the material was about fifteen years old. The results of recent plastic surgery must have been considerable. Moreover, some items are too comprehensive and should be further distributed, as, for instance:

Item 15, loss of thumb and one or more fingers, left hand.
16, loss of thumb and one or more fingers, right hand.
17, loss of two or more fingers, left hand.
18, loss of two or more fingers, right hand.
29, loss of fingers, accompanied by injuries of other fingers, left hand.
30, loss of fingers, accompanied by injuries of other fingers, right hand.
33, loss of toes.

There is a noticeable absence of data in regard to loss of foot, and items 1 and 2, loss of one arm, and item 31, loss of one leg, might be further analyzed according to different scales for loss of forearm, below elbow, at elbow, between elbow and shoulder, and at

shoulder, etc. Items 15, 16, 17, 18, 29 and 30 alone represent 495 out of 2,323 dismemberments or over one fifth. Another fifth is represented by case of loss of one eye, and this one item has justly roused many suspicions as to its accuracy.

The number of permanent total and partial disabilities has already been referred to. These groups of cases proved to be the most difficult to handle. The reason is obvious. In the discovery of these conditions and especially in their appraisements, the element of human judgment enters very largely. It is quite likely that for some time the tendency in this country has been and will be to judge these cases too lightly. For this reason the number of cases to be expected was estimated as low as appeared consistent with safety. But all of this is not an excuse for failure to check up this part of the table; on the contrary, it is an argument in favor of urgency of such a check.

Still more important is this distribution according to degree of disability. The Standard Accident Table distributes these 2,442 accidents on the theory that they are compensated in a manner similar to that of most European countries, i. e., by partial weekly benefits, as the exact language of the law seems to require in most states. As a matter of fact, however, this method is hardly used at all in any of the states, outside of possibly Massachusetts and the states which have adopted the Massachusetts act. In fact this difference between the Massachusetts act and most other acts created some very serious difficulties which will be referred to presently. The typical American method of compensating these injuries, provided for in many states by specific language of the law and followed in many others by imitation without any definite legal sanction, is by valuation in proportion to total loss of part.*

Under the circumstances an entirely new rearrangement of the 2,442 cases is necessary as an alternative to that by degree of disability. Three years ago the situation was not quite clear, nor were any data on this subject available, but by this time such information could be obtained either from the official records of some industrial accident commissions or from the private records of insurance companies without any excessive labor or cost. The question to be solved is: What sort of injuries constitute this group of accidents and what is the customary method of their compensation?

* For the discussion of this method see "American Methods of Compensating Permanent Partial Disabilities," by I. M. Rubinow, *Proceedings*, Vol. II, pp. 235–252.

Finally as to the group of temporary total disabilities, from evidence obtainable this appears perhaps less in need of revision than other groups. But, on the other hand, it is the easiest group to construct on the basis of American states, because the classification of temporary injuries according to duration is easily made, and the necessary data are found in most state compensation statistics reports.

The absence from the table of cases of temporary partial disabilities has been frequently commented upon. The reason for it is altogether a technical one, the absence of reliable data at the time. But some information has been accumulated and must be available at present. This, of course, is not so much a separate group of accidents as a supplementary benefit for accidents appearing in the table as temporary total cases, or an alternative treatment for so-called permanent partial cases. In fact in one sense all the 2,442 cases in most states may be designated as temporary partial cases, either because they are compensated in approximation to dismemberments for a specified number of weeks, or because they are subject, as are the temporary total cases, to a maximum time or money limit. But the failure to recognize the temporary character of the cases, or at least of their compensation, introduces serious errors when acts with different time limits for such cases are compared.

In addition to the main table there are certain supplementary tables which must be made use of when the provisions of the law require it. The most important of these deal with the fatal accidents, their distribution according to marital condition, and number of dependents. Three years ago, when there was neither time nor facilities for ascertaining actual conditions, some broad assumptions were made. It is unfortunate that these assumptions are still being used without any serious effort to verify them. The effect of that assumption upon the final valuation of this table is very strong. And dealing with social rather than physical facts, they are subject to much greater fluctuation as between state and state. Data of this character for each compensation state should have been carefuly collected by this time.

Methods of Valuation.

So much for the Standard Accident Table. Still more important are the methods of valuation of the table for the purposes of computing the differential. Unfortunately, no detailed account

of these methods with proper actuarial material has as yet been published beyond a few brief remarks in my article in the first volume of the *Proceedings,* and in my book on the Standard Accident Table. It is manifestly impossible to go into any detailed description of these methods here. But assuming that to most members of this Society these methods are fairly familiar, the weakest spots may be pointed out.

The method of valuation, with proper discount for present values of either annuities certain, or temporary or life annuities subject to effect to mortality and remarriage, permits of a certain degree of accuracy, provided an agreement is reached as to most fundamental assumptions. And yet substantial differences have occasionally developed when differentials have been independently computed by different actuaries. This is a subject which the writer feels constrained to discuss with some delicacy, and therefore the discussion will be carried on in general terms, rather than by reference to specific cases.

The valuation of temporary total disability, and of dismemberments, where a dismemberment schedule exists, is a simple problem, which has not developed any difficulties or controversies. The problem of valuation of death benefits is actuarially more complex, but the possibilities of error arise largely from differences of structure of the Standard Accident Table than the methods of computation. A suggestion might be made that the wholesale computation for the "average widow" is rather crude, especially when the factor of remarriage enters into the compensation, and a refinement of this method by the use of actual age data of a fairly representative number of widows would not seem to offer any unsurmountable difficulties. As to the deep and grave problem of remarriage (deeper and graver than the problem of marriage) perhaps it is best not to raise it at this hour at all, beyond simply referring to it. That the habits, looks and other qualifications of American widows may differ in many respects from those of Dutch widows, all actuaries, it is hoped, recognize, but the situation for many years may not permit of any remedy, since a remarriage table cannot be constructed in a year or two. Perhaps the suggestions may be thrown out, that while a brand new table cannot be constructed in a few years, a comparison between the expected and actual results for the remarriage may be made, as such comparisons are made for expected and actual

mortality, and on the basis of ascertained gain from excessive remarriage, or loss from insufficient remarriage, adjustments on differential tables could be made, especially if some regularity should be discovered in these results from year to year. With some 1,500 fatal accidents in New York state alone sufficient material should become available for such a task in a few years.

There are, however, three important problems in connection with the methods of valuation of the Standard Accident Table and the computation of the differential, that must be more carefully considered.

1. The valuation of permanent partial tables.
2. The computation of medical costs.
3. The valuation of the effect of limits.

Valuation of Permanent Partial Disability Cases.

It has already been indicated that the possible error here may partly be charged to the deficiency of the table itself, in that it fails to differentiate between permanent and temporary partial disabilities. Such failure was due at the time to the difficulty of obtaining reliable data. Besides there is undoubtedly a certain difficulty in proper interpretation of the terms. Most of these cases are of a permanent character as far as the surgical nature of the injury is concerned (though this permanency may not be as absolute as in the case of dismemberment). Occasionally some of these troublesome fractures, dislocations, contractions, etc., may be overcome after a lapse of years, but more frequently the economic damage gradually vanishes, even though the physical results of the injury remain. As a result, even in Germany, the classical country of permanent pensions for partial disability, injuries in many cases seemingly permanent in the early stages gradually continue to recover for years in succession.

The absolute distribution of the accidents among the five groups is not comparable with the Standard Accident Table, because German statistics deal only with accidents of over 13 weeks' duration. The significant feature of the above table, however, is the reduction in the proportion of permanent partial cases from 44.27 per cent. to 37.40 per cent., a reduction of some 15 per cent. As a matter of fact this does not demonstrate the entire strength of the tendency, because the earliest results shown are for accidents occurring in 1904

as at the end of 1905, on an average of 18 months after the occurrence of the accidents.

The following data demonstrate this conclusively:

RESULTS OF 65,205 CASES OCCURRING DURING 1904.*

Result of Accident.	At End of 1905, Per Cent.	At End of 1906, Per Cent.	At End of 1907, Per Cent.	At End of 1908, Per Cent.
Fatal	7.63	7.81	7.96	8.06
Total permanent disability	.93	.80	.78	.81
Partial permanent disability				
Under 25 per cent	25.90	25.38	24.60	24.17
25–50 per cent	12.74	10.97	10.07	9.27
50–75 per cent	3.80	3.48	3.18	3.01
75–100 per cent	1.83	1.29	1.15	.95
	44.27	41.12	39.00	37.40
Temporary partial disability				
Under 25 per cent	19.67	14.14	10.59	8.15
25–50 per cent	3.93	2.14	1.39	.98
50–75 per cent	.50	.23	.16	.12
75–100 per cent	.48	.17	.15	.11
	24.58	16.68	12.29	9.26
Complete recovery	22.59	33.59	39.97	44.37

Equally significant is the evidence that nearly 25 per cent. of these accidents at some time fall into the category of temporary partial disability cases. Moreover, the reduction in the number of cases of high partial disability is greater than in low partial disability cases.

What effect has the disregard of these conditions upon the computation of differentials?

Two methods have been used in arriving at the valuation of the 2,442 permanent partial cases, the choice between the two methods depending more upon the language of the act than the actual methods used in their adjudication. In the case of the differential for a new act, this language is the only thing to go by. But that does not justify the failure to adjust the method to the actual conditions of claim settlement when these conditions can be ascertained.

One method is to calculate the average degree of disability for the 2,442 cases and to compute their valuation in the hypothesis that a partial weekly benefit proportionate to the degree of dis-

* Henry J. Harris, Ph.D., "Industrial Accidents and Loss of Earning Power." German experience in 1897 and 1907. Bulletin 92 of the United States Bureau of Labor Statistics.

ability is paid for the exact maximum duration for which the law provides. As a matter of fact in very few states does this method of compensation actually prevail, and yet this method of compensation has been used in a great many state law differentials.

Now, since the purpose of all differentials work is a relative and not an absolute valuation and since no matter what the actual method of compensation used, there must be some relation between the amount of compensation and the gravity of the injury, the error thus introduced would not appear very serious, so long as both states compared (e. g., the old Massachusetts act and the act of the state for which a differential is desired) had provisions essentially similar. But if, as explained, the error committed is in assuming that in all the 2,442 cases payment will continue up to time limit provided for the law—and if this is a substantial difference in such time limits, the resulting error may be (and in fact in several states was) very grave, as can be readily shown by one or two other illustrations.

Let us for instance compare the New Jersey act and the Connecticut act. Under these two acts the valuation of the 2,442 cases is as follows: (the average degree of partial disability being 22.4 per cent.).

Average weekly benefit (both states) .50 w.w. $\times$ .224 = .112 w.w.
Average annual benefit (both states) .112 w.w. $\times$ 52 = 5.82 w.w.
Duration of benefit (deducting 11 w. for total disability):

New Jersey, 300 w. — 11 w. = 289 w. = $5\frac{29}{52}$ years = 5.5577.
Connecticut, 312 w. — 11 w. = 301 w. = $5\frac{41}{52}$ years = 5.7692.

Present value of temporary annuity, age 37, Am. Exp. Table, $3\frac{1}{2}$ per cent.:

New Jersey, for 5.5577 years — 4.7323,
Connecticut, for 5.7692 years — 4.9329.

Cost per case:

New Jersey, 5.82 w.w. $\times$ 4.7323 = 27.542 w.w.,
Connecticut, 5.82 w.w. $\times$ 4.9329 = 28.709 w.w.

Cost for group of 2,442 cases:

New Jersey, 27.542 w.w. $\times$ 2,442 = 67.258 w.w.,
Connecticut, 28.709 w.w. $\times$ 2,442 = 70.107 w.w.

The difference in this case is so slight that the final differential cannot be seriously affected by any error in the assumption.

But the situation becomes very much different when a longer time limit is provided.

Thus the 8-year time limit in Illinois results in an annuity value of 6.4336; a value per case of 5.82 w.w. $\times$ 6.4336 = 37.444 w.w., and a total value for the group of 37.444 w.w. $\times$ 2,442 = 91.338 w.w., an increase of over 20,000 w.w. or about 5 points in the differential. And yet it is quite certain that the existence of the higher limit does not effect all cases, in fact it is doubtful if it affect any perceptible proportion of them and the increase of the 5 points appears in a nature of penalty for the language rather than any substantial provision of the act.

The situation becomes even more aggravated where no limit, or only a very high money limit, exists. If the language of the act is followed, purely fictitious values are obtained. Compensation actuaries need not be reminded of the serious controversies that resulted from differences of opinion upon this one point when the New York differential was being computed in 1914. In other states, also, e. g., Maryland, Colorado, etc., the method had to be discarded entirely because values obtained were palpably fanciful. For a time the entire method of differentials or at least the Standard Accident Table seemed in danger of being discarded, because the results obtained appeared too much at variance with the probabilities of the case. It is, I believe, admitted now, that the difficulty was one of detail, or at worst of faulty application, rather than of the method itself.

As an emergency measure, in several of the state differentials referred to, an entirely different method of valuation of this group had to be resorted to. Namely, since partial disability cases were compensated by comparison with dismemberments, an arbitrary relationship was assumed between the cost of an average dismemberment, and an average partial disability case. Under this rule the chance of introducing errors is very much smaller, since, as already explained, the valuation of dismemberments is a simple matter, and the difference of valuation of the permanent partial cases in two laws would simply strengthen the difference in the valuation of dismemberment.

The only assumption necessary is the ratio between the cost of the average dismemberment case and the average permanent partial disability case. The percentage of 70 per cent. was hit upon in the case of one or two states for lack of more accurate informa-

tion. It is very unfortunate that until now more reliable information is still not available, and that of all the states Nevada seems to be the only one which published definite figures concerning this issue. Expericnce for three years in that state indicates the following results:*

	No. of Cases.	Total Compensation Entire Cost.	Average Cost per Case.
Dismemberment.....	111	$84,760.88	$763.61
Permanent partial disability.....	125	96,015.10	768.12

The fact that the proportion in the number of cases of the two groups is almost identical with that assumed in thc Standard Accidcnt Tablc (125:113 = 1.13, and 2,442:2,300 = 1.06) may add a little additional weight to this exhibit. If the experience of Nevada is characteristic, then the average cost of a permanent partial disability is equal to the average cost of a dismcmberment, and since in no case was such an assumption made in the computation of differentials, they are all faulty to that extent. But why should there be any doubt concerning this very important matter? Surely what Nevada has done, Massachusetts, New York or Pennsylvania can do to ascertain the true facts.

Cost of Medical Aid.

Perhaps no other point in the computation of the differentials presented so many difficulties as the casc of medical aid. In distinction to the situation in regard to permanent partial disability cases, there are almost no standards in the medical provisions of the acts. The differences are innumerable and bewildering.† The time limits are different, the money limits are different, the degrce of administered supervision oevr medical fees in the various states is different and the customary standards of medical fees also differ widely in various localities. Added to all this, and seriously complicating the issue, is the fact that the valuation of the Standard Accident Table is madc in terms of weeks' wages, while medical cxpenses have no relationship to the wages of the insured.

* Report of the Nevada Industrial Commission, 7/1/13–6/30/16, p. 69, Table 21.

† I. M. Rubinow, "Medical Aid under Compensation," *Journal of Political Economy*, June–July, 1917.

Since the entire basis of the differential method is to ascertain the average cost per accident, the question of medical costs reduces itself to the average cost per accident under different acts. While there were some statistical sources (private and public) available in 1914 to the Committee, they were expressed in terms of a proportion of medical costs to all other compensation costs, for several states with substantially different medical provisions.

The method therefore used at the time was as follows. The proportion between medical cost and all other costs was ascertained for Massachusetts from official data as 24.5 per cent., for Illinois from data of casualty companies as 27.7 per cent., etc.

2. The gross valuation of the table for Massachusetts, excluding medical aid, without deduction for discount of future payments, was determined at 361.947, for Illinois at 430.200 w.w. Medical costs therefore were for Massachusetts 361.947×24.5 per cent. $= 88.677$ w.w., for Illinois 495.605 w.w. $\times$ 27.7 w.w. $= 137.283$ w.w.

3. These figures were accepted as typical of the cost of medical aid, under the respective provisions, the Massachusetts figure for 2 weeks, and the Illinois figure for 8 weeks with a $200 limit. A similar method was used for one or two other states, and for all other states the respective figures were obtained by a process akin to interpolation. The provisions for medical aid were compared with those of Massachusetts or Illinois and a figure in w.w. was assumed as representing the cost of medical aid for 100,000 accidents either by loading or discounting the known figures.

In other words, from somewhat crudely ascertained values of average cost of medical aid per accident, expressed in weeks' wages for a few states, similar values were derived for all other states. Thus in Massachusetts the average cost was .89 week's wages, in Illinois 1.37 weeks' wages, but in California 1.50 weeks' wages. In Connecticut the cost was assumed to be 20 per cent. over Massachusetts, or 1.07 w.w., in Michigan as $\frac{1}{8}$ over that in Massachusetts, or 1. w.w. per case; wherever the medical provisions of the new act were identical with those of an older act, the same average cost (in weeks' wages) was also assumed, as for instance in Iowa or Louisiana, equal to Massachusetts; in Indiana as in Connecticut, etc.

Since the problem was to arrive at many unknown quantities from a few known ones, perhaps no apologies need be offered

for the method and its use in 1914. But the opportunities of error were obviously many and grave. In several check computations of the state differentials made within the last year for official bodies, or private clients, I was forced to differ substantially on this amount to be charged for medical aid. There is no intention to thrash these differences out before the Casualty Actuarial and Statistical Society of America, but it may be worth while to point out what these opportunities of error in the method above described are.

1. The very proportion between medical costs and compensation as obtained from accident boards or private casualty companies may be wrong because of errors in estimating unpaid losses. It is known, for instance, that in the beginning of compensation experience almost all states show an alarming proportion of payments absorbed by medical aid, simply because the heavy compensation payments do not mature so rapidly.

2. The application of this proportion, arrived at from experience, to the standard table valuation, will carry with the cost of medical any error that is contained in the table. Thus, if the proper valuation for the table for Massachusetts (old act) were 300,000 w.w., then medical aid would become 73,500 w.w., and if it were 400,000 w.w., then medical aid would become 93,000. It is, of course, very unfortunate that instead of errors of independent judgment as to the separate items counterbalancing each other, one error should create another one.

3. The projection of the probable cost in other states from these data is only a crude guess. The influence of the variable time and money limits is assumed from the known differences of cost in a few states, though these differences may be due to causes other than legal provisions.

4. Finally, in assuming the same cost in weeks' wages for two states because the medical provisions are identical, we disregard the possible difference in average wages, which may give a very much different monetary value.

It is evidently unfortunate that such leeway should exist for independent judgment in what should be a matter for a non-biased computation. The failure to consider the wage differences is perhaps the gravest cause of error. Supposing that the cost of medical care per accident for 2 weeks in Massachusetts has been ascertained at .89 w.w. per case. Supposing we have sufficient influence

to justify the assumption that an extension of the medical aid to 8 weeks would increase the cost by 50 per cent. Does it follow that this cost under a far western act, giving 8 weeks, would be .89 w.w. $\times$ 1.50 = 1.33 w.w.? By no means, for if average wages in the western states are 75 per cent. higher, then an increase in money cost by 50 per cent. might result in a lower value when expressed in weeks' wages $\left(\frac{.89 \times 1.50}{1.75} = .76 \text{ w.w.}\right)$.

Evidently accurate data as to average wages of injured are absolutely necessary for a proper computation of the medical cost, and even if such data were not available when the compensation system is first introduced, there is imperative necessity for an early computation of such data from accident records. Surely there is no justification for failure to revise medical costs on the basis of true wages during the very first year. There is only one accurate basis for computation of medical cost, and that is an average for a fairly large number of cases, and all differentials should receive an early correction on that basis.

Effect of Limits.

The problem involved in the measurement of the effect of limits is a familiar one to compensation actuaries. There is no more interesting chapter in the history of compensation rate-making than Mr. S. Herbert Wolfe's effort to take the limits into consideration. The method suggested by him for use by the Massachusetts Employees Insurance Association (now the Liberty Mutual Insurance Company), and discarded after a brief trial, called forth a very lively discussion at the time. Mr. Wolfe's suggested method in brief consisted in eliminating from the premium charge any excess over that part of the individual wage which corresponds to the weekly maximum benefit; as a corollary it became necessary to assume fictitiously high wage expenditures, whenever the minimum required it. Difficult in Massachusetts, the method would break down altogether wherever several conflicting limits are contained in the law for different injury groups, as, for instance, in New York or in Utah. The decision of the Massachusetts Employees Insurance Association to abandon the method after a very brief trial was additional evidence of the practical difficulties it presented.

In any case the fairly uniform experience of compensation underwriting is in favor of making the premium a charge upon the

total payroll, as the practical objections to its manipulation are very serious indeed.

Instead of this, the actuarial committee proposed a different method, very much simpler, though perhaps lacking the same degree of accuracy.

The method requires fairly reliable data as to the distribution of wages of injured persons. On the basis of such a series, it is possible to compute the actual cost of compensation as well as the hypothetical cost which would have occurred if there had been no limits. The proportion between these two quantities indicates the discount or loading which the limits require. It is unnecessary to go into all these complications at this place.

The possible elements of inaccuracy introduced by any faulty application of this method are mainly two:

1. The absence of data. This is particularly noticeable in case of new compensation acts. The character and quality of wage statistics published by separate states are subject to great fluctuations. It is idle to expect a satisfactory statistical service in many of our political units because of very small population and the heavy burden of state government that it must carry. Sometimes an indifferent assortment of average wage data may exist, but for the problem under discussion such data are absolutely useless. And as already explained, even if wage frequency data are available in such states they refer to all persons employed and not to injured persons. Only after some experience with compensation can the necessary wage statistics be obtained.

As an emergency measure it may be necessary to utilize available statistics of a neighboring state, but such a substitute is seldom reliable, not only because of variations in wage levels, but even more because of variations in industrial activity. Wage in an agricultural state, a mining state, and an industrial state are not comparable, even though they be adjacent to each other.

2. The rapid aging and "spoiling" of the wage data. As yet no printed discussion of this point has appeared, as far as the writer is aware, though the point was brought up by Dr. Downey in a personal discussion. This point has become particularly important at the present time. At best, published wage statistics are several years old. Because of a rapidly increasing price level, and otherwise abnormal industrial conditions, nominal money wages are rising by leaps and bounds. It is doubtful whether com-

pensation acts can or will be amended to meet these conditions. But it is evident, how deeply some maximum limits may cut into the compensation benefits as a result of such wage increases. To quote an extreme example: An $8 limit in Colorado reduces the compensation of a $20-a-week man from the ostensible 50 per cent. to 40 per cent., but if the wages of that same worker rise to $25 or $30, the $8 limit, unchanged, reduces the compensation level to 32 per cent. or to 26.7 per cent., and correspondingly should reduce the cost. Of course statistical data must be retrospective and must be of some age. But this consideration alone makes at least an annual recomputation of all differentials absolutely necessary.

The Selection of a Proper Basis.

For three years the Massachusetts Act of 1912 has continued to serve as the foundation of law differentials, until its use for this purpose has acquired a certain sanctity in the eyes of the insurance business. To the interested outsider, the justification of this tradition does not appear equally obvious. The writer very recently had some difficulty in explaining to the business men of a western state the meaning of the basic pure premium on metal mining, as the cost under the Massachusetts law, because the obvious objection was raised that there could be no such thing, since metal mines were as rare in Massachusetts as snakes in Ireland.

The objections against Massachusetts remaining the basic state are as follows:

1. The act being obsolete, the pure premiums are abstractions which find no test of experience in actual practice of compensation insurance, except in so far as certain recollections gradually growing dimmer may remain within the memory of the underwriter.

2. While most acts, though differing in detail, follow a certain system of compensation, Massachusetts is distinct from other acts; in fact, with Rhode Island and Texas they represent a certain somewhat exceptional type of compensation acts, primarily because of their different treatment of dismemberments, which under the exact language of the law receive both specific dismemberment benefits and compensation for loss of earning capacity, instead of only the former as in most other acts, or only the latter as in the case in a few. The difficulty which was experienced in 1914, and, as far as the writer is aware of, has not been cleared up as yet, is to find out exactly what proportion of dismemberments have actually

received both forms of compensation and what the second payments amounted to. The original assumption was a rather wild guess and until it has been tested not only the Massachusetts but all other differentials must be questioned.

It is true that in so far as the present basis of pure premium is derived not from Massachusetts experience alone but from the combined experience of many states, the effects of any possible error in valuation of the Massachusetts Act are somewhat neutralized. That is, if the valuation of the Massachusetts act has been too low, then the differentials are all too high, but the basic pure premiums are also too low (since in the process of reduction to the basic standard, the losses in each state are divided by the differential for that state) and so the final effect upon premiums may not be very high. Nevertheless there would have been a decided gain in reality if a typical American Act, as for instance New Jersey or Pennsylvania, were taken as a basis.

The specific error introduced by a wrong valuation of the Massachusetts law depends, of course, largely upon the volume of the Massachusetts experience introduced into the computation of the basic pure premium. For this reason the combination of the experience of as many states as possible for the purpose of arriving at a fairly reliable pure premium, and for purposes of eliminating any errors brought in by mistakes in the state differential, is the more important.

Group Differentials Versus a General Differential.

Remains the very important question as to whether a general law differential for a state at large is at all dependable, or whether the theory did not require separate differentials for each classification, or at least for groups of classifications, and if so, what the basis of such groupings should be.

That one general differential was only a rough approximation, or at least an averaging of differences, was recognized by the writer even three years ago.* If is of course but another aspect of the problem already considered in an earlier part of this paper, whether one Standard Accident Table was at all justified for rate-making, useful as it may remain for the purposes of comparing the liberality of the law. Since the Standard Accident Table is but a means of weighing the comparative importance of numerous

* *Proceedings,* Vol. 1, p. 21.

differences which distinguish one law from another, it follows that if accident distribution according to gravity varies from one classification to another, so will the law differential vary. And in addition, other differences must be considered which are not contained in the main body of the Standard Accident Table, as for instance, marital distribution of the wageworker, the proportion of non-resident alien dependents (when subject to special legal provisions) and above all, the wage differences. The theoretical case for the necessity of a series of differentials rather than one, being thus obvious, the first practical question is: how wide is the probable inaccuracy introduced by a general law differential. Is it so serious that it would militate against the propriety of using of general differential at all?

This question will perhaps be best answered by a series of practical illustrations, for which purpose an act with a rather high differential has been selected. Obviously the greater this differential, the greater the possible variations that may result from group differences in accident distribution. The valuation of these two acts, according to the earlier data, the only ones available to the writer, but close enough to illustrate the point, is as follows:

Nature of Accident.	Number.	Mass. Value.	Average per Case.	Per Cent. of Total.	State Value.	Average per Case.	Per Cent.	Ratio Between Two Acts.
Fatal.....	932	97,877	105.03	23.6	138,860	149.00	19.9	1.42
T. P. D.....	113	23,796	210.58	5.7	72,635	642.81	10.4	3.05
P. P. D.....	2,442	34,637	30.56	18.0	136,284	55.81	19.6	1.83
Dismember	2,300	82,209	35.74	19.8	122,153	53.11	17.5	1.49
T. T. D.....	94,193	42,923	.51	11.5	80,518	.94	12.9	1.84
Medical aid	(100,000)	88,677	.89	21.4	137,283	1.37	19.7	1.54
Total.....	100,000	415,124	4.15	100.0	696,733	6.97	100.0	1.68

The second act remains unnamed intentionally, because the question of the accuracy of its valuation is not involved. Furthermore, for the sake of the argument made at this place, the general accuracy of the Standard Table, and of the methods of its valuation are here assumed.

An examination of this table demonstrates that while the general differential is 1.68, for various groups of injuries the differential fluctuates between 1.42 (for fatal accidents) and 3.05 for total permanent disability, the state providing life indemnities for such injuries. The final differential is a result of the weighting of

the specific differentials by the respective weight of the cost of accidents of various groups, as the following computation indicates.

	1. Accident Group Differential.	2. Weight.	One × Two.
Fatal accidents	1.42	23.6	33.5
Permanent total	3.05	5.7	17.4
Permanent partial	1.83	18.0	32.9
Dismemberment	1.49	19.8	29.5
Temporary total	1.84	11.5	21.2
Medical aid	1.54	21.4	83.0
		100.0	167.5

In the case of this particular state, the differential would rise if cases of total permanent disability were more frequent, it would decrease if the fatal cases were more frequent, as compared with the Standard Accident Table, etc. In case of another state, the relationship might be very much different, of course. The question remains how much a slight variation in the table would affect the differential, or, otherwise expressed, how big must the deviation from the standard table be, to influence the differential substantially. For it is true of statistics, as of law, that it does not concern itself with trifles. Undoubtedly, very complicated mathematical formulae might be worked in answer to this question. It is sufficient, however, here to use a few simple illustrations.

In a simplified form the Standard Accident Table might be stated thus:

Fatal cases	9
T.P.D. cases	1
P.P.D. cases	24
Dismemb. cases	23
T.T.D. cases	941

In the following table the differential has been computed for a few assumed modifications of the Standard Accident Table.

	Fatal.	T. P. D.	P. P. D.	Dism.	T. T. D.	Differential.
1	3	1	24	23	947	1.72
2	9	1	24	23	941	1.68
3	18	1	24	23	932	1.63
4	9	–	24	23	942	1.61
5	9	2	24	23	940	1.75
6	9	3	24	23	939	1.80
7	9	1	12	23	955	1.66
8	9	1	36	23	931	1.70
9	9	1	24	11	955	1.66
10	9	1	24	35	931	1.70

The variation of differentials due to deviation from the Standard Accident Table is, therefore, a real factor, albeit not an important one, as may appear at first glance. The question remains, how extensive are the deviations in the distribution of accident gravity, as between one classification and another. It has, I believe, been suggested that separate differentials be computed according to the amount of pure premium, serious and fatal accidents predominating in industries of high hazard and therefore of high pure premium. Too much dependence must not, however, be placed upon this hypothesis, for distribution of accidents by gravity is a statistical concept, separate and distinct from accident frequency or hazard.

It is unfortunate that as yet no satisfactory and ample figures on this subject have been published in this country. With the growing tendency of Schedule Z to call for the number of accidents, as well as the cost, such data might be compiled, and thus an opportunity obtained to test the theory, whether there is any definite relation between the pure premium and the distribution of accidents by gravity. But in absence of such American data, some use may be made of European statistics for purposes of illustration only. In the following table the data are given for French experience, covering years 1901–1908 and over 27 million years of exposure. The general accident rate was 65 per thousand employees per annum, and fatal accidents constituted 4 per *1,000 accidents,* and all permanent injuries 17 per *1,000 accidents.*

The 17 industrial groups are arranged in order of declining accident frequency—with the following results:

Industry.	Accident Frequency (per M. Employees).	Fatalities (per M. Accidents).	Perm. Disabilities (per M. Accidents).	Fatalities and Permanent Disabilities Total per 1,000 Accidents.
Metallurgy	241	2	9	11
Building and construction	121	10	16	26
Chemicals	121	4	9	13
Metals, base, working	119	2	15	17
Earthenware	68	4	13	17
Woodworking	65	4	34	38
Paper	64	4	24	28
Stone cutting	56	5	23	28
Food articles	53	5	14	19
Commerce, etc	45	5	13	18
Hide and leather	30	3	18	21
Printing and publishing	29	1	23	24
Textiles	28	2	27	29
Metals, precious, working	20	4	18	22
Lapidary	20	3	13	16
Straw, feather and hair	15	3	18	21
Clothing	6	2	14	16

If the proportion of fatal accidents varies between 1 and 10 per thousand accidents, and the proportion of permanent disability cases between 9 and 34 (and a finer analysis by subdivisions of these 17 larger industrial groups would undoubtedly bring forth even wider fluctuations), it becomes evident that one general Standard Accident Table does not succeed in creating thoroughgoing justice in compensation rates.

Problems of Organization.

If the point made earlier hold true, that some method of calculating state law differentials is essential, and that valuation of accident series is the best method to compute such law differentials, then it necessarily follows that a system of graded differentials is the next step to be undertaken. It does not represent any unsurmountable difficulties. But it does require careful actuarial work, based upon detailed and accurate statistical information.

Of course such work can not be done without some cost. But can there be any question as to justification of expenses? The errors due to the failure to improve methods of computing law differentials may result in some premiums being 10 or even 20 per cent. out of the way. The business of compensation insurance is rapidly approaching the $100,000,000 level. There is many an undertaking in which such errors represent a loss of a larger amount than the entire organization of scientific differential work would call for.

That the method of law differentials in 1917 is in about the same stage of development as in 1914 is neither to the credit of the casualty actuarial profession or the casualty insurance business. In the February, 1917, report of the Actuarial Subcommittee repeated references are made to the obscure points in differential theory which have to be investigated, only to be dismissed with the statement that "the departure from past practices is too radical and the volume of data and the extent of time at the disposal of the committee too limited to warrant the abandonment of established methods."*

The organization of a standing committee is recommended, but a similar recommendation was made about eighteen months ago without any perceptible results. The Statistical Committee of

* Report of Actuarial Subcommittee, February, 1917.

the National Association of Industrial Accident Commissions has developed statistical standards, but they are scarcely being used. The Casualty Actuarial and Statistical Society had a committee at work for two years, but even the most obvious shortcomings of the Standard Accident Table have not yet been corrected. The reasons are probably obvious ones: The casualty company statistician is pressed by everyday business problems of his corporation, the Bureau officials are engrossed in the numerous demands of intercompany relations, the governmental actuaries and statisticians with detail problems of efficient administration.

Only a special organization, properly equipped scientifically, and free of other duties, can render this necessary service.

For one not directly connected at the present time with any one insurance institution any dogmatic attitude on the proper organization and affiliation of such a service may be an unwarranted presumption. There are, however, a few general observations that may be safely made at this time.

1. If the differential method is to be retained at all, the scientific problems connected therewith become public problems rather than problems of private business. That compensation rate-making is a public function has been the accepted point of view for some time in some states, and the list of states requiring a public control of compensation rates is rapidly growing: Massachusetts, New York, Pennsylvania, California, Colorado, Oklahoma, Texas, New Jersey, Wisconsin, Utah, are only a partial list. Perhaps two thirds of the compensation insurance is already under governmental control as to rates.

2. Though the right of each state to control the rates within its own jurisdiction cannot be denied, it is nevertheless obvious that no state can stand on its own legs exclusively. That the pure premiums are obtained from a nationwide experience, has been recognized. But the mistaken thought frequently prevails that when the method of law differentials is reached, each state is concerned only in its own differential. There is, to my knowledge, no central governmental authority for the control of the differentials as a whole. But a little reflection will show that every state, which presumes to exercise an intelligent, and not a purely formal control over rates, is interested in accurate differentials for all other states without any exception, because every mistake in the law differential must have its effect upon the basic pure premium compiled

from experience scattered all over the country, and converted to the basic law, which is the old Massachusetts Act.

As the work of readjusting basic pure premium proceeds, more and more reliance must be placed upon the purely arithmetic results of the experience, and less and less upon underwriting judgment expressing itself in so-called "selected pure premiums." Such application of underwriting judgment, somewhat akin to the action of "woman's intuition" we hear so much about ("I don't know why I think so, but I am sure I am right"), might remain a valuable adjunct to premium-making, if the basic law were a living system which creates many valuable subconscious impressions—but it must fail when the basic pure premium under an obsolete act becomes a bodyless abstraction.

If therefore the experience of the entire country is to be utilized, if the basic pure premiums are to be saved from gross errors, then all law differentials must be subjected to strict public control, not of one insurance department, not of one state Bureau, but of some national organization in which all compensation states and all insurance carriers are represented. To be sure, no matter what particular form of organization be developed, the same students who have been developing the theory and practice of compensation rates heretofore will continue to do so in the future; but the auspices must not be circumscribed by any geographical or business limitations.

To sum up, the following conclusions may be formulated on the basis of the lengthy discussion here presented.

1. The basis of compensation rates must be found in actual experience—the purpose is to determine what compensation actually does cost, not what it should cost in accordance with any theoretical formula.

2. Barring certain factors which result in time changes, the best basis of determining what compensation will cost in the future is found in the experience of the past.

3. For certain important classifications, the experience within one state is so wide that a fairly accurate average cost may be ascertained for that state and classification alone, and as far as such classification is concerned, the differential method is unnecessary and should not be introduced for mere purposes of uniformity.

4. For most classifications, however, the combination of experience

for the entire country is absolutely imperative, and in such cases a system of differentials is indispensable, both for the purpose of reducing the experience to a common basis and to derive rates for each state from the common basis.

5. A state law differential is absolutely necessary in order to construct at least approximately accurate rates when a compensation law is introduced in a new state.

6. The underlying principle of law differentials must be applied to in order to adjust rates to any modification of the benefit schedule.

7. Between the two methods suggested for computation of state law differentials, the experience method and the valuation of a Standard Accident Table method, the latter method should be preferred, because it is also applicable to new acts and new amendments, and because it has the advantage of comparative simplicity.

8. While the Standard Accident Table has produced differentials, which on the whole were roughly accurate, and perhaps more so than could be obtained by means of any information at hand at the time, a more careful revision of the Standard Accident Table is nevertheless the need of the hour. This applies particularly to details of dismemberments, to the degree of disability of permanent partial cases and the number of dependents in fatal cases.

9. The difficulties experienced at present relate more to the method of valuation of the Standard Accident Table than to the table itself. The most important points on which improvement is necessary are—the valuation of permanent partial disability cases in conformance with the practice obtaining in the various states, a more careful computation of the effects of limits by means of a current enquiry into wage conditions, and a better method of valuation of the cost of medical aid.

10. The time is ripe for substituting group differentials for one level differential. These group differentials should be based upon a classification of industries according to frequency of fatal accidents and permanent disabilities, thus requiring the construction of a series of accident distribution tables.

11. As a basic law, a more typical act than the obsolete Massachusetts should be selected—either New York or Pennsylvania with the introduction of group differentials the necessity for one basic state law would vanish. The state having the largest experience in any classification should be the basic state for the classification and its differential.

12. All these results cannot be accomplished unless the whole subject of differentials is made a subject of continuous careful study. Such study, and the cost of it, are amply justified since law differentials are the most important factor in determining final rates, which must be made by actuaries instead of underwriters.

13. The basic scientific investigation cannot be left to officers of insurance companies, nor to supervising officers, all of whom are under constant pressure of current duties. There is urgent need of a separate organization under whatever name, to pursue these statistical and actuarial enquiries.

14. The point of view is rapidly gaining ground that the computation of compensation insurance rates is a public business, and must be subject to public control. The preparation of the differentials would therefore be best conducted under the combined auspices of all insurance departments, industrial commissions and state rating bureaus.